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XXVI. A Study of the Relation of Distracted Motor Performance to Performance in an Intelligence Test

By Miles A. Tinker

This investigation was undertaken with the hope of ascertaining whether there is any relation between motor performance under distraction to performance in an intelligence test. Often, at the end of an intelligence test, one hears the complaint that certain distractions, such as "nervousness" or the necessity for working against time, prevented the subject from doing his best. It was our intention to see whether these reports of "nervousness" or an objective test of distractibility would show a negative correlation with performance in the intelligence test.

Our results in the end were negative. No correlation was apparent, in part for the reason that the distractor instead of distracting proved a spur to attention. We are presenting the findings, nevertheless, because it is of value to have the outcome of such an attempt known, and because the results show in a striking manner the fact, already known in other contexts, that a distractor may prove an aid rather than a hindrance to many kinds of performance.

We had 39 subjects, of whom 33 were naive and 6 were members of the graduate department of experimental psychology.

All subjects were given the Otis Group Intelligence Scale; Advanced Examination, Form A.[1]

For the motor test for distracted performance we used two mazes, designed with a single univocal path without bifurcations in order to test speed and steadiness of motor performance but not learning. Each maze consisted of a path which wound from the periphery to the center of the maze and then out again according to the plan of the "walls of Troy." The total length of a maze is 72.5 in., and a maze covers a space of 11 by 9 in. The walls of the path were made of 0.25 by 0.25 in. brass strips, screwed to a wooden base covered with celluloid, with a path one-eighth in. wide left between. The two mazes were identical with the exception that one had notches one-sixteenth in. deep and one-eighth in. long, separated by one-eighth in., all along the walls of the path. The notches in one wall were directly opposite those in the opposing wall. A metal stylus, one-sixteenth in. in diameter, was used to trace the path. The stylus and the maze were connected electrically with markers on a kymograph so that a graphic record of all contacts of the stylus with the walls of the maze was obtained. A time-line on the record gave the time for traversing the maze. At *S*'s ear on top of a post was a cigar box, for a resonator, with an electric bell attached. The bell was wired so that, when a switch was closed, it would ring every time the stylus came in contact with the wall of the maze.

The notched maze was intended to place a greater emphasis upon accuracy as against speed, since *S* might catch the stylus in the notches if he hurried. As a matter of fact, however, the notching reduced accuracy as well as speed, so that the introduction of the notched maze did not enable us to reduce accuracy and speed to a single variable as we had hoped to do.

The ringing of the bell close to *S*'s head when a contact was made was intended to be a distraction and to induce "nervousness."

[1] *Jour. of Educ. Psychol.*, 1918, 9, 239-261; 333-348.

Procedure

The intelligence test was given according to the directions in the Manual[2] except for the following reductions in the time allowed for certain of the tests: test 4, from 6 to 4 min.; test 5, from 6 to 5 min.; test 7, from 3 to 2.5 min.; test 8, from 4 to 3 min.; test 9, from 6 to 4 min.; test 10, from 3 to 2 min. We made this change because we have found from experience that, if the full time is given, too many finish before the time is up.

At the end of the test the *S*s were asked to answer certain questions intended to reveal the degree of "nervousness" which they experienced in taking the test. The following directions were read to *S*:

"This is a test of steadiness. You are to take the stylus and try to trace the path through the maze without toucing the sides. The problem is to get through in the shortest possible time with the least number of touches. Every time you touch the side the error is recorded electrically and counts against your score."

The order of tracings in the two mazes was as follows:

1.	Smooth.	No distraction
2.	Notched	
3.	Notched	
4.	Smooth	
5.	Smooth	Unexpected distraction
6.	Smooth	Expected distraction
7.	Notched	
8.	Notched	
9.	Smooth	

Before the fifth tracing the switch which connected the bell was closed without the knowledge of *S* and the bell rang every time a contact was made. Before the sixth tracing *S* was warned that the bell was still attached and would ring every time that he touched the wall of the path with the stylus.

At the end of the tracings questions were again asked in order to bring out *S*'s opinion of his degree of "nervousness" in performing the test.

Results

Averages for the results of the motor performance test and of the intelligence test are given in Table 1, and the significance of some of the differences between these averages is indicated in Table 2.

In the first four rows of Table 1, if we compare the tracings in the smooth and notched mazes for no distraction and for the expected distraction, we find that both the time of tracing the maze and the number of contacts vary in the same direction and in approximately the same degree. For this reason we felt justified in combining the results for a distractor and for no distractor in the fifth and sixth rows of the table, in order to show the general difference between the smooth and notched mazes. Originally we had introduced the notched maze with the intention of rendering a rapid traverse of the maze difficult and thus of placing a premium upon accuracy as against speed. We had thought in this manner to obtain some comprehension of the supposedly inverse relationship between speed and accuracy, and thus to be able to reduce the two measures of performance to one. We find, however, that the relation is not inverse, for the introduction of the notches not only lengthens the time but also decreases accuracy (in spite of the fact that the notches reduce the probability of contact since the path is wider between opposing notches). It is apparent

[2] *Otis Group Intelligence Scale, Manual of Directions*, 1920.

therefore that we must in this case regard speed and accuracy in the maze as at least partially independent variables, since they vary together and not inversely when the change is made from the smooth to the notched maze.

It appears also from Table I that the effect of the introduction of the expected distractor is similar in direction and amount for both the smooth and the notched maze (see the first four rows). Accordingly we have combined these results in the seventh and eighth rows so as to show the general effect of the introduction of a distractor. It is here evident that the presence of the distractor decreases the speed and increases the accuracy. Such a result is equivocal, for the reason that we can not tell whether the decrease of speed is responsible, at least in part, for the increase in accuracy. We have seen that speed and accuracy may vary independently as they do when notches are introduced in the walls of the maze; it is natural therefore to regard them as independent here. The argument for their independence is, moreover, considerably strengthened by the results from the introduction of the "sudden distractor," *i. e.*, the distraction begun without warning to *S*. In the ninth row of Table I we see that speed was not appreciably changed by the distraction, whereas the accuracy was greatly increased. Certainly, then, the variation must have been independent in this case, and it seems highly probable that it is to be so considered when the expected distractor is compared with the normal case.

What happened must have been approximately as follows. In the first four trials the *S*s settled down to a given degree of speed and accuracy for each of the two types of mazes. In the fifth trial they were startled into a higher degree of attention by the unexpected ringing of the bell whenever an error was made. The average speed of the preceding trials was maintained approximately, but the "distractor" acted as a spur to attention and the *S*s consequently worked with much greater precision. In the subsequent trials where the distractor was continued they may have been fatigued: the *S*s slowed down and became less accurate than with the sudden distraction; they remained, however, more accurate than in the initial undistracted trials, either because of the attentive spur of the distraction or because of the slower rate. That intended distractors, especially when intermittent, may fail to distract and may instead act as a spur to attention and thus lead to intensification of impression or to shortened reaction time is well known.[3] In our experiment some of the *S*s commented upon the steadying effect of the ringing of the bell, and also upon the advantage that it gave them in notifying them when they made a contact. On the other hand many *S*s, who reported that the test had made them "nervous," stated that the bell made them especially nervous. It is not impossible that the bell not only made the *S*s "nervous," but also spurred them on to better work, and that in general the conditions of "nervousness" in such a test—and perhaps also in an intelligence test—may also be the conditions of accurate performance.

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[3]H. Münsterberg and N. Kazaki, The Intensifying Effect of Attention, *Psychol. Rev.*, 1894, 1, 39-44; A. J. Hamlin, Attention and Distraction, this Journal, 1896, 8, 3-66; J. E. Evans, The Effect of Distraction on Reaction Time, *Arch. of Psychol.*, 1916, no. 37, vol. 5, 1-53; E. E. Cassell and K. M. Dallenbach, The Effect of Auditory Distraction upon the Sensory Reaction, this Journal, 1918, 29, 129-143.

TABLE 1. Average performance in speed and accuracy in motor test of steadiness. Figures are averages for time (secs.) and number of contacts with the walls of the maze for 39 subjects. The numbers in the second column are series numbers. Performance on the Otis intelligence test is shown in the last two rows.

		Time		Contact	
		Av.	M. V.	Av.	M. V.
No distraction	Smooth maze: 1, 4	76.4	21.2	74.5	15.6
	Notched maze: 2, 3	86.0	20.2	109.8	24.6
Expected distraction	Smooth maze: 6, 9	82.5	30.3	61.6	15.2
	Notched maze: 7, 8	92.5	25.9	93.9	21.2
Smooth maze	1, 4, 6, 9	79.8	20.0	67.9	13.1
Notched maze	2, 3, 7, 8	91.6	21.4	100.4	21.1
No distraction	1, 2, 3, 4	81.1	18.5	90.3	15.5
Expected distraction	6, 7, 8, 9	90.5	27.2	79.8	14.0
Sudden distraction	5	82.4	33.2	69.2	16.5
Otis test	Score	155.5	26.2		
	% accur.	.859	.070		

Table 2. Significance of differences between averages of Table 1. The table shows the significance of the difference found in changing from the smooth to the notched maze, and in introducing a sudden or an expected distractor during the performance. D/P.E.$_D$, the ratio of the difference to its probable error, is the usual measure of significance; P_D, the probability of difference, is, on the assumption of the normal law, the probability that the difference will not vary from itself by an amount more than itself.

		$\frac{D}{P.E._D}$	P_D
Smooth vs. notched maze	Time	2.98	.956
	Contacts	9.67	1.000
Sudden vs. expected distraction	Time	1.39	.651
	Contacts	3.63	.986
No distraction vs. expected distraction	Time	2.11	.845
	Contacts	3.73	.988

Table 3 gives the results which the problem was planned to educe. It was hoped that change in performance in the maze under the introduction of a distractor would prove an objective measure of distractibility

or "nervousness." A significantly high negative correlation of this change with performance in the Otis test might indicate that such distractibility as an individual characteristic was a special disadvantage in an intelligence test; whereas a high positive correlation might have meant that the distractor acted as an attentive spur and that "nervousness," so defined, was of advantage in taking an intelligence test. As a matter of fact, however, the correlations are all low. Since speed and accuracy seem to be independent variables in the maze, they had to be treated separately, and the effect of the one or the other eliminated by partial correlation. In the same manner score and accuracy on the Otis test were separately cared for. The last column of Table 3 shows, however, that distractibility neither as measured by speed (T) nor as measured by accuracy (C) is highly or significantly correlated with either of the measures of performance on the Otis test, even when correction is made by partial correlation for variation of the two factors not entering into the correlation.

TABLE 3. Coefficients of correlation (products-moments method) and partial coefficients of correlation between T, C, S, and A, defined as below. The probable errors of these coefficients are all between .06 and .10.

T = change in time for traversing maze when expected distractor is introduced.

C = change in number of contacts made in traversing maze when expected distractor is introduced.

S = score in the Otis intelligence test.

A = accuracy (ratio of items right to items attempted) in the Otis intelligence test.

$r_{TC} = -.37$	$r_{TC.S} = -.39$	$r_{TC.A} = -.39$	$r_{TC.SA} = -.39$
$r_{TS} = -.08$	$r_{TS.C} = -.16$	$r_{TS.A} = -.10$	$r_{TS.CA} = .07$
$r_{TA} = -.10$	$r_{TA.C} = -.18$	$r_{TA.S} = -.06$	$r_{TA.CS} = -.13$
$r_{CS} = -.17$	$r_{CS.T} = -.21$	$r_{CS.A} = -.08$	$r_{CS.TA} = -.13$
$r_{CA} = -.17$	$r_{CA.T} = -.21$	$r_{CA.S} = -.08$	$r_{CA.TS} = -.13$
$r_{SA} = .67$	$r_{SA.T} = .67$	$r_{SA.C} = .67$	$r_{SA.TC} = .67$

There is little to be gained from the results of the questionaries given the *S*s after the intelligence test and after the maze trials. The *S*s tended to follow the suggestion of the questions and to admit "nervousness." There were 21 who reported themselves "nervous" in both the intelligence and the maze tests; 6 who admitted "nervousness" in neither; and 12 who were "nervous" in one but not in the other.

Conclusion

At first sight our results seem mainly negative. The introduction of an auditory distraction during a test of motor steadiness may not distract the *S*, even though he reports a conscious disturbance, but may spur him on to more accurate manual performance. The distractor has a measurable effect, howbeit in an unanticipated direction. The sensibility of an individual to this sort of effect is not, however, prognostic of his performance in an intelligence test.

There is, however, an application of a known psychological fact which the experiment renders the service of indicating. We have known that

sensory impression may be reenforced attentionally by the facilitating effect of an intended distractor that does not distract, and that reaction times may be shortened in the same manner. We have now shown that manual precision of movement may similarly be increased by the concomitance of an intermittent intended distractor. Obviously the next experiment is to make the analogous direct attack upon the intelligence test itself. May it not be that the presence of a distractor will improve the performance of a group in an intelligence test? At any rate we know that complaints about distraction have in themselves little value as bearing upon the distracted performance. It may be unpleasant to be "distracted;" it is generally unpleasant to have the attention spurred; but, pleasant or unpleasant, the spur may result in improved performance for the individual and thus justify itself in spite of the contrary opinion of the *S*. Even if an apparent distraction does not improve intelligent performance, we have certainly no way of knowing whether it interferes. The direct experimental attack needs yet to be made.